Time delay in atomic photoionization
with circularly polarized light

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Atomic or molecular photo-ionization in a circularly polarized electromagnetic (EM) field exhibits a number of features that are absent in the case of linear polarization. One such effect is dependence of the photo-ionization probability on magnetic quantum number m of the target electron or, in other words, on the direction of the rotation of the electron relative to the polarization plane of light. This dichroism effect has been known for a long time [1,2].

Time delay [3] is a quantity related to the phase of the ionization amplitude, which provides an insight into development of the photo-ionization process in time. Here we present a study of the dichroism in time delay in atomic photo-ionization by circularly polarized light. As a model we choose photo-ionization of the Li atom. We solve the time dependent Schrödinger equation for the Li atom in the field of the circularly polarized EM laser pulse propagating along the z-axis. We call the atomic electron co- or counter-rotating with the field if its angular momentum projection m on the z-axis is m>0 or m<0, respectively. Our study shows that not only co- and counter-rotating electrons escape with different probabilities, but their time delays are also markedly different.
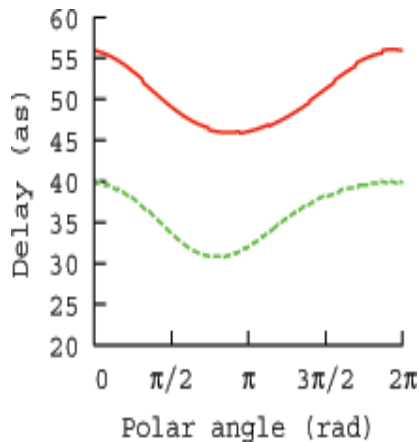

Fig.1 Time delays as functions of the polar angle in the polarization plane of the EM wave.   Ionization from the lithium states $2p_m$ with m=1   (red solid line), and m=-1 (green dash). The peak strength of the EM field is 0.05 a.u. (8.7×10^{13} W/cm^2),   the photon energy is 0.5 a.u (13.6 eV), the pulse duration is 3 optical cycles (1fs).

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[3] E.P.Wigner, Phys. Rev. **98**, 145 (1955).